

# PHILCO CORPORATION

A SUBSIDIARY OF *Ford Motor Company*.

APPLIED RESEARCH LABORATORY

Blue Bell, Pennsylvania  
Mitchell 6-9100

15 January 1965

TO: National Aeronautics and Space Administration  
Goddard Space Flight Center  
Glenn Dale Road  
Greenbelt, Maryland 20771  
Attention: Contracting Officer, Code 248

SUBJECT: Theoretical and Experimental Investigation on  
Modulation-Inducing Retrodirective Optical Systems.  
Contract NAS 5-9765 (Philco B006), Monthly Contract  
Progress Report No. 2 for the period 20 November  
to 20 December 1964.

## SUMMARY OF WORK ACCOMPLISHED DURING THE REPORT PERIOD

An experimental apparatus for investigating Raman lasers was set up during this report period. Work on the band-edge modulation of a single-crystal SbSI was also performed. Low-frequency modulation on the SbSI was observed.

### 1. Experimental Activities

#### A. GaAs Lasers

The lasing diodes, B-1, B-2, and B-7,<sup>1</sup> fabricated from epitaxial-grown material failed prematurely and their pumping efficiency could not be determined. The cause of these failures was insufficient alloying of n-type surface to the supporting tab, resulting in poor thermal

1. See the Monthly Contract Progress Report No. 1 (15 December 1964) for notations.

N65-83539

FACILITY FORM 602	ACCESSION NUMBER	(THRU)
	6	<i>None</i>
	(PAGES)	(CODE)
	CD 57903	(CATEGORY)
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contact. The n region is only 18 microns thick, and the alloying, carried out at high temperature, must be limited to avoid shorting out the junction.

Due to poor wetting of the n surface by the indium bead, diodes made by alloying the thicker p region to the tab had high series resistances. By putting a layer of sintered nickel and then another layer of unsintered nickel on both n and p surfaces before soldering the indium, improved wetting on both regions was obtained in later units. The series resistance in this case is from 0.1 to 0.2 ohm.

Several mounting techniques are being considered to provide better mechanical support of the diode and improved heat transfer to the heat sink.

The diffusion in closely compensated GaAs ( $N_D/N_A = 2$ ,  $N_D = 2 \times 10^{18}$ ) was conducted at 800°C, where concentration dependence of the diffusion constant is much less than it is above 826°C. The piece still converted to p type. A possible means of circumventing this problem is to diffuse the material with an acceptor different from the one used for compensation.

A temperature-monitoring mount for an injection laser is being designed to provide for fine tuning of the laser wavelength. By changing temperatures, two effects will be observed. The band gap will be narrowed and the mode pattern of the Fabry-Perot focus will be shifted toward longer wavelengths by increasing temperatures. The first effect is approximately  $(dE_g/dT)_{GaAs} = -5 \times 10^{-4} \text{ eV/}^\circ\text{K}$ .<sup>2</sup> The change in mode pattern is due largely to expansion of the crystal and is approximately 3 Å when going from 4°K to 77°K.

#### B. Generation of Alkaline Lines by Stimulated Raman Emission

An experimental apparatus for investigating Raman lasers has been set up, and the block diagram is shown in Figure 1. The purpose of this type of arrangement is to obtain a high-power Q-switched laser beam by means of a reflection from a rotating prism at one end of the cavity. A 400-cps synchronous motor is driven by a 400-cps single-phase

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2. Selected Constants Relative to Semi-Conductors, Pergamon Press, 1961, p. 26.

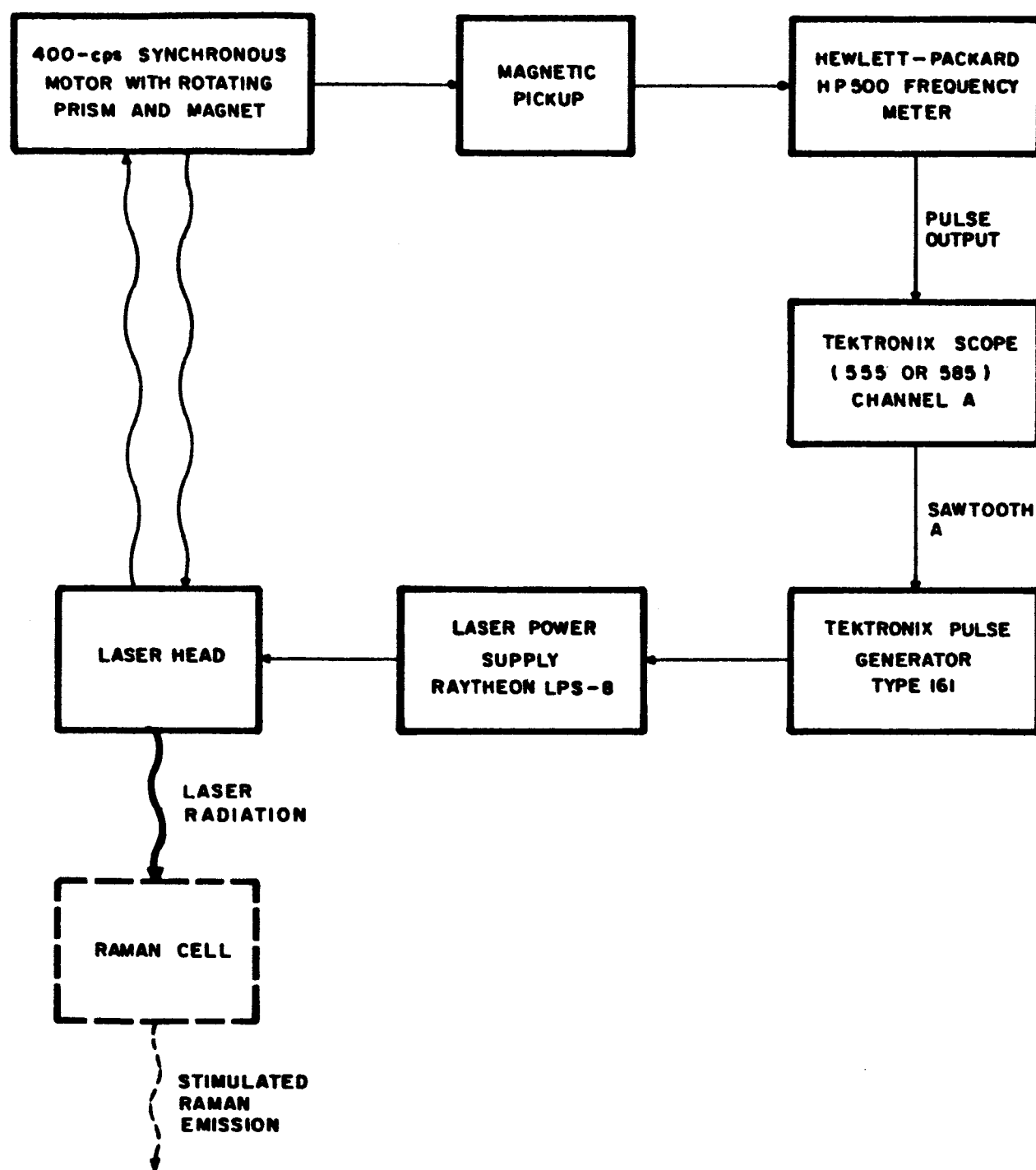


Figure 1. Block Diagram of Raman Laser Setup

power line. The magnet attached to the motor shaft generates a 400-cps sine wave which is detected by a magnetic pickup and fed into a frequency meter having a pulse output. This pulse is then fed into a Tektronix scope (Type 555 or 585). The sawtooth A output from the scope triggers a Tektronix pulse generator (Type 161). The output pulse from the generator in turn triggers the laser power supply. The cavity is formed only at the instant the prism is correctly aligned with respect to the laser rod. The relationship between the time of formation of the cavity and the time of the pulse is determined by directing a beam of light on the prism from the direction of the laser rod and detecting the light reflected back upon itself by means of a photomultiplier. The time of formation of the cavity is then determined by comparing the time lag between the photomultiplier pulse and the frequency meter pulse. The flashtube in the laser head can be set to trigger at a time when optimum output will be obtained.

### C. Band-Edge Modulator

The speed of response of the absorption-edge shift in SbSI crystals was studied, having in view its use as a modulator.

The first setup, using a 6328 Å gas laser as the source and a crystal with a face dimension of 0.7 cm x 0.1 cm in conjunction with a photomultiplier tube and an oscilloscope, failed to show any absorption-edge shift. A much smaller crystal was then mounted on a microscope slide and provided with electric contacts. The slide was placed on the stage of the Bausch and Lomb polarizing microscope. The crystal image was projected on to the photomultiplier by means of a prism. A microscope lamp as a light source was used with a stabilized power supply, and the appropriate wavelength was obtained with an interference filter. The signal was still too weak to show shift of the absorption edge upon application of the dc field to the crystal. The photomultiplier was then replaced by a GaAs photodiode mounted directly above the end of the microscope tube. The ocular was taken out and precautions were taken to make sure that all light reaching the diode came through the crystal. (X21 magnification was used.) By tilting the interference filter slightly, the wavelength of the incident light was adjusted to the wavelength of the absorption edge. Upon application of the dc field, a change of the light level was clearly observed when a chopped light beam was used. Polaroid photographs of the oscilloscope indicated about 20 milliseconds response time, at least for a large part of the effect. An ac field of 60 cps has not yet shown any modulation. However, modulation was observed at lower frequencies

(10 to 20 cps).<sup>3</sup> The modulation efficiency drops rapidly from the dc to low-frequency ac fields. An improved system will be set up to investigate modulation at higher frequencies.

#### PRINCIPAL INVESTIGATORS' TIME DEVOTED TO WORK

The principal investigators assigned to the project and the time devoted to the work by these individuals from 20 November 1964 to 20 December 1964 are as follows:

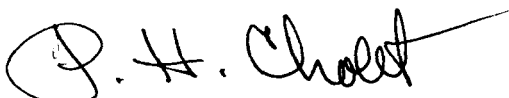
<u>Personnel</u>	<u>Man-Hours</u>
G. K. Chang	120
J. Powers	127
W. Haas	90
A. Varga	32
C. Wang	15
G. Racette	60
D. Cornelius	58
P. Cholet	8

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3. The low-frequency signal is obtained from a low-frequency function generator (Hewlett-Packard 202A) coupled to a General Radio amplifier. The maximum potential is about 300 volts, which corresponds to 3000 volts/cm field strengths at the crystal.


## PLANS FOR THE NEXT INTERVAL

Generation of alkaline lines by the stimulated Raman emission of some organic liquids will be investigated. Improved technique of fabricating and mounting injection lasers will be conducted. Modulation of single-crystal SbSI at higher frequencies will be studied.

  
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Approved:

  
M. E. Lasser, Director  
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